APPENDIX M.

WATER RESOURCES

M.1 303d List of Impaired Water Resources
M.2 Current Water Quality Findings and Monitoring Programs Within the South Florida Caribbean Network.

APPENDIX M.1

303D LIST OF IMPAIRED WATER RESOURCES WITHIN THE SOUTH FLORIDA CARIBBEAN NETWORK

What is the 303(d) List?

Section 303(d) of the Clean Water Act (CWA) requires states and territories to develop a list of waters not meeting water quality standards or not supporting their designated uses. Total Maximum Daily Loads (TMDLs) are required for the waters determined to be impaired based on these detailed assessments because of technology-based effluent limitations, current effluent limitations required by State or local authority, or other pollution control requirements are not stringent enough to meet current water quality standards.

Background and Sources of information for the 303(d) List

The 303(d) Lists are based primarily on the state and territories 's 1996 305(b) Water Quality Assessment Report ("305(b) report"), which uses a watershed approach to evaluate the state's surface waters, ground waters, and wetlands. All existing and readily available water quality related data (chemical, physical, and biological) and information were assembled and evaluated in the development of the 305(b) report, including but not limited to data in EPA's STOrage and RETrieval (STORET) database, the Statewide Biological Database (biological assessments), and fish consumption advisory information. The 303(d) lists are re-evaluated and updated about every two years. Here we report the 303(d) list 2004 update for the National Parks in both Florida and the Virgin Islands.

303D LIST OF IMPAIRED WATER RESOURCES WITHIN THE SOUTH FLORIDA CARIBBEAN NETWORK

PARK	WATER_NAME	BODY	PARAMETERS	PRIORITY	TMDL_ DUE
EVER	TAMIAMI CANAL	STREAM	Dissolved Oxygen, Mercury (Based on Fish Consumption Advisory), Cadmium, Copper	Low	2007
EVER	WCA3B	STREAM	Dissolved Oxygen, Mercury (Based on Fish Consumption Advisory)	High	2006
EVER	AREA B TAMIAMI CANAL	STREAM	Dissolved Oxygen, Nutrients	Low	2010
EVER	EVERGLADES NATIONAL PARK L-67 CULVERT US	STREAM	Dissolved Oxygen, Iron	Low	2007
EVER	EVERGLADES NATIONAL PARK SHARK SLOUGH	STREAM	Dissolved Oxygen, Iron, Mercury (Based on Fish Consumption Advisory), Nutrients	Low	2007
EVER	C-113	STREAM	Dissolved Oxygen, Nutrients	Low	2011
EVER	EVERGLADES NATIONAL PARK TAYLOR SLOUGH	STREAM	Dissolved Oxygen, Iron	Low	2007
EVER	TRANSECT T3	STREAM	Dissolved Oxygen	Low	2011
EVER	LONG SOUND	ESTUARY	Dissolved Oxygen	Low	2011
BICY	L-28 INTERCEPTOR	STREAM	Dissolved Oxygen, Nutrients, Mercury (Based on Fish Consumption Advisory)	Low	2011
BICY	L-28 GAP	STREAM	Dissolved Oxygen	Low	2011
BICY	TAMIAMI CANAL	STREAM	Dissolved Oxygen, Mercury (Based on Fish Consumption Advisory), Cadmium, Copper	Low	2007
BICY	WCA3A CENTER SECTOR	STREAM	Dissolved Oxygen, Nutrients, Mercury (Based on Fish Consumption Advisory)	Low	2011
BISC	nothing listed within park boundary - however MILITARY CANAL - SAMPLE LOCATION JUST OUTSIDE OF PARK – UPSTREAM OF THE PARK HYDROLOGICALLY	STREAM	Lead, Cadmium, Copper-- Heavy metals from Homestead Airforce Base. Suggested by DEP-Tallahassee	Low	2010

PARK	WATER_NAME	BODY	PARAMETERS	PRIORITY	TMDL_ DUE
SARI	SALT RIVER MARINA	ESTUARY	Dissolved Oxygen	Medium	2001
SARI	SALT RIVER ESTUARY	ESTUARY	Dissolved Oxygen	Medium	2001
SARI	SALT RIVER BAY	ESTUARY	Dissolved Oxygen	High	2001
VIIS	CANEEL BAY	ESTUARY	Dissolved Oxygen, Turbidty	Medium	
VIIS	CRUZ BAY	ESTUARY	Dissolved Oxygen, Turbidty	Medium	
VIIS	CINNAMON BAY	ESTUARY	Dissolved Oxygen	Low	
VIIS	MAHO BAY/FRANCIS BAY	ESTUARY	Dissolved Oxygen	Low	

APPENDIX M.2

CURRENT WATER QUALITY MONITORING PROGRAMS WITHIN THE SOUTH FLORIDA/CARIBBEAN NETWORK AND REVIEW OF REGIONAL HYDROLOGY SUMMARIES

Current water quality monitoring programs within the South Florida / Caribbean Network and review of regional hydrology summaries.

This is a summary of the current water quality monitoring programs established within the South Florida / Caribbean Network (SFCN). The assets of each park's water monitoring program are summarized along with general trends. A regional section covering the major water quality programs working in the South Florida region (below Lake Okeechobee) has been included in order to account for Everglades Restoration efforts. Additionally, we have included a review of regional hydrology summaries.

Big Cypress National Preserve

Big Cypress National Preserve continuously monitors twenty water stations (see figure in supplemental information section). Station establishment was paid for by the South Florida Water Management District (SFWMD). The routine calibration of the stations is paid for by SFWMD funds. These stations record water temperature, water depth, rainfall, and conductivity. Big Cypress Preserve Hydrologist, Robert (Bob) Sobzack, maintains the stations and calibrates the instrumentation according to a memorandum of understanding with the funding agency SFWMD. The hydrology data is downloaded via radio telemetry to Miami and stored in the DBHYDRO database (glades.sfwmd.gov/pls/dbhydro_pro_plsql/). The rainfall, water depth and input/output flows data is summarized weekly, monthly, and yearly. This product is currently a live web product (**www.fgcu.edu/bcw/hcu.htm**), which is in the process of being migrated to the SFCN webpage.

The long-term water quality record for Big Cypress Preserve was most recently summarized in USGS open file report *Water Quality in Big Cypress National Preserve and Everglades National Park – Trends and Spatial Characteristics of Selected Constituents* (Miller et al. 2004). As the water level decreases due to seasonal cycles there is an increase in the breakdown of organic matter and a build up of organic waste and nutrients. Long-term changes in water quality (1959-2000) in the Big Cypress Preserve are less pronounced than has been observed in Everglades National Park. However, Big Cypress Preserve generally has higher total phosphorous (> 0.015 mg/L) compared to Everglades National Park. This difference has been attributed to higher natural sources of phosphorous in the shallow soils and ground water. Big Cypress Preserve has lower sulfate (1 mg/L) and chloride (20 mg/L) than Everglades National Park due to limited canal transport to the preserve (Miller et al. 2004).

Big Cypress Preserve has low levels of trace elements, pesticides, and other toxic organic compound. Atrazine in the water column, and heptachlor, expoxide, lindane and p,p'-DDE in canal bed sediments exceeded aquatic life criteria in 2 out of 304 samples (1, 2, and 16 % in samples respectively, Miller et al. 2004). Miller and McPherson (2001) found that there were difference sources of bottom sediment and water contaminants in the Baron River area of the Big Cypress Preserve. Specifically, lead, copper and zinc levels (normalized to aluminum) exceeded normal limits. Polynuclear aromatic hydrocarbons and p-cresol (normalized to organic carbon) exceedances are probably related to road traffic or are from an old creosote wood treatment facility.

Biscayne National Park

Biscayne National Park currently monitors thirty water stations (see station location map in the supplemental section). Biscayne National Park ecologist Sarah Bellmund is currently uploading records (1988 to present) into the Data ForEVER database [see South Florida Regional Monitoring section]. Biscayne National Park plans to evaluate the data set for outliers and make recommendations about long-term monitoring of some of the stations. The overall goal is to use the long-term data to evaluate model outputs regarding Everglades Restoration effects on Biscayne Bay. Suggestions may include establishment of more stations on the eastern part of the park to determine water quality issues for reef locations.

Additionally, Biscayne Bay is monitored by Miami-Dade County Department of Environmental Research (DERM) Steven Blair (305-372-6853 blairs@miamidade.gov). SFWMD has summarized DERM's long-term (1979 to 2005) water quality sampling at 13 sites within Biscayne Bay. Additionally, Florida International University Southeastern Environmental Research Center maintains 25 stations within Biscayne Bay for SFWMD water quality program (see the South Florida Regional Monitoring). Within Biscayne Bay, specific water quality targets have been established for ammonia (0.01 mg L-1) and nitrate/nitrite nitrogen (0.05 mg L-1); all other contaminant parameters should have declining long-term trends under the proposed restoration.

Everglades National Park

Three agencies are maintaining approximately 400 water quality stations in Everglades National Park as part of the Everglades Restoration (See station location map in the supplemental section). Because of this the National Park Service has dedicated hydrology staff investigating the trends in the physical water parameters. A major asset for Everglades National Park is the Data ForEVER database established and maintained by Kevin Kotun (Supervisor Physical Hydrologist of the South Florida Natural Resource Center). Additional information is in the South Florida Regional Monitoring section of this report. The long-term water quality (1959-2000) trend indicates that upstream changes in water management have produced increases in chloride concentrations and specific conductance in the two main drainages of Everglades National Park at Shark River Slough and Taylor Slough (Miller, McPherson, Sobczak, Clark 2004).

Dry Tortugas National Park

Dry Tortugas National Park water quality monitoring is part of the Florida Keys National Marine (FKNMS) Sanctuary (http://www.fknms.nos.noaa.gov/welcome.html) water quality protection program. Essentially Dry Tortugas National Park is used as a pristine site for the coral reef ecosystem that surrounds the Florida Keys. The Dry Tortugas water quality is monitored by the Southeast Environmental Research Center (SERC) Water Quality Monitoring Network (http://serc.fiu.edu/wqmnetwork/) funded by the Environmental Protection Agency Water Quality Protection Plan. SERC monitors 15 permanent stations for the following water quality parameters: salinity (practical salinity scale), temperature (°C), dissolved oxygen (DO, mg/L), turbidity (NTU), relative

florescence, light attenuation (K_d, m-1), dissolved nutrients nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4^+), dissolved inorganic nitrogen (DIN), soluble reactive phosphate (SRP), total unfiltered concentrations of nitrogen (TN), organic nitrogen (TON), organic carbon (TOC), phosphorous (TP) and silicate ($Si(OH)_4$), chlorophyll *a* (CHLA µg l^{-1}) and alkaline phosphatase activity (APA, µM h^{-1}). Additionally, in the marine environment the Florida Institute of Oceanography maintains the C-man Station DRYF1 data record from 1992 to September 2005 and has since been replaced by Station PLSF1. The National Oceanic and Atmospheric Administration (NOAA) National Data Bouy Center manages the data (http://www.ndbc.noaa.gov/station_page.php). Recently, the U.S. Geological Survey has established a number of monitoring wells to track Fort Jefferson's waste water treatment effluent (See station location map in the supplemental section).

Virgin Islands National Park

There are 15 water quality sites in Virgin Island National Park (See station location map in the supplemental section). Monitoring includes surface water samples for temperature, conductivity, pH and dissolved oxygen and nutrient analysis. This data is currently being inputted into one database with the data being checked for errors. There is a site map in the supplement information section. These sites are sampled by Sheri Caseau (sheri_caseau@nps.gov). Limited progress has been made towards reviewing the current water quality data trends.

Additionally there are 11 reef locations in which water temperature has been collected continuously from 1988 at the reef surface. This data is currently collected by SFCN staff. The data is maintained by a joint effort between the South Florida / Caribbean Network and the Virgin Island National Park data manger Christy Loomis. The reef temperature data set was critical to investigating the 2005 coral bleaching impact to the reefs of the Virgin Islands (Figure 1).

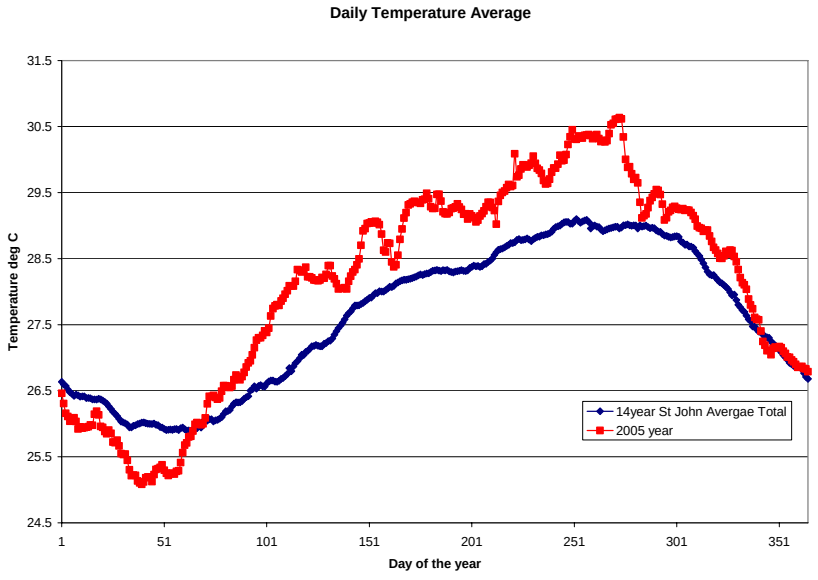


Figure 1. 2005 Daily reef water Temperature compared to the 14 year period of record.

Buck Island Reef and National Monument
Salt River Bay National Historical Park and Ecological Preserve

The territorial government of the Virgin Island Division of Environmental Protection / Department of Planning and Natural Resources Protection (DPNR/DEP) monitors two beach sites and two open water sites at Buck Island and one beach site at Salt River (See station location map in the supplemental section). This monitoring is related to water quality for beach swimming at these sites tracking *Fecal coliform* and *Enterococcus coliform*. Additionally, there are two reef temperature sites being monitored by the SFCN.

The South Florida Regional View

A number of regional water initiatives in South Florida relate directly or indirectly to the $10 Billion Department of Interior's Comprehensive Everglades Restoration Plan (http://www.evergladesplan.org/). In this section we first present the monitoring network assets and then some of the regional summary of the hydrology trends within South Florida.

South Florida Regional Monitoring:

The Estuarine Water Quality Monitoring Network was established in 1991 to characterize status and trends in water quality of Florida Bay and has since expanded to cover much of the South Florida region (southwest coast of Everglades National Park and Biscayne Bay). It is funded by the South Florida Water Management District and managed by Dr. Joseph N. Boyer of the Southeast Environmental Research Center (SERC), Florida International University. Water quality data is collected from 28 stations in Florida Bay (EVER), 22 stations in Waterwater Bay (EVER), 25 stations in the Ten Thousand Inlands (EVER), 49 stations on the Southwest Florida Shelf (EVER) and 25 stations in Biscayne Bay (BISC). This information is readily downloadable at http://serc.fiu.edu/wqmnetwork/.

The Data ForEVER database is a regional water database that covers: Everglades National Park, Big Cypress National Preserve and Biscayne National Park plus many of the dominate water management control structures in South Florida. The database currently tracks approximately 851 stations covering a large variety of parameters. The Data Forever database supports queries by data type, agency supporting station, station name, observation point, aggregation level, validation status, units and output type. The database is populated with stations maintained by: National Park Service, U.S. Geological Survey, and South Florida Water Management District. Stage, rain, flow, and salinity are critically important parameters being monitored in the South Florida Everglades (Table 1). Dissolved Oxygen and pH are not routinely monitored parameters. This is mainly due to difficulty in the automation of measuring these parameters. Automation of deployment is important since most of these stations report via telecommunication. Sites have been installed and supported by Federal (NPS, USGS,

and NOAA), State (SFWMD, FIU) and Local (DERM) agencies (Table 2). State agencies support the majority of the stations (439) followed by Federal (379), and then the local government (33, Table 2).

Table 1 Number of sites which record the specific parameter of interest.

Parameter	Number of sites recoding the Parameter
Air temperature	**32**
Bottom temperature	**146**
Water temperature	**296**
Salinity	**314**
Flow	**409**
Ground water level	**32**
Head water	**270**
Rain	**614**
Stage	**795**

Table 2 Number of stations by funding Agency.

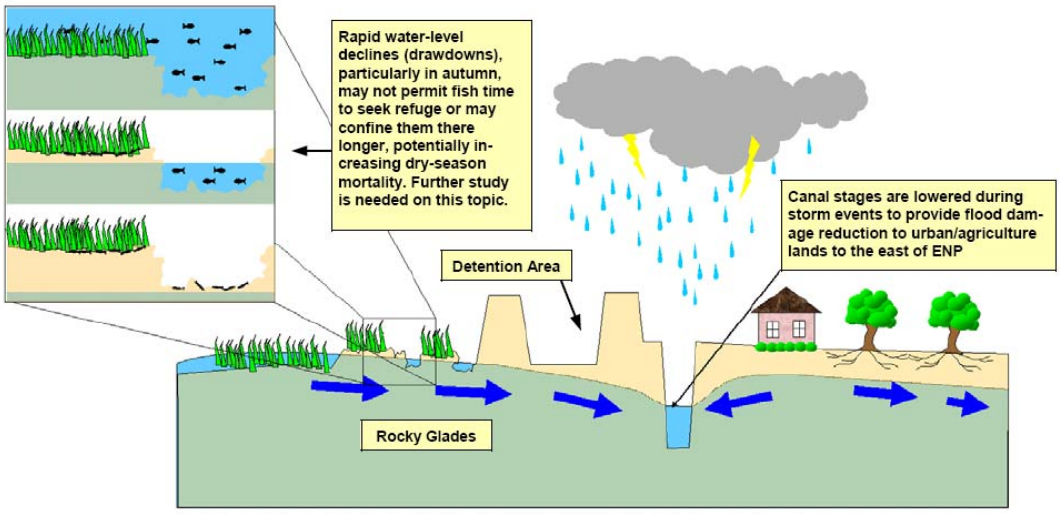
Agency	Number of sites
DERM – Dade County Environmental Resource Management	**33**
FIU – Florida International University	**30**
NOAA – National Oceans and Atmospheric Administration	**7**
NPS_Big_Cypress – Big Cypress Preserve	**18**
NPS_BISC – Biscayne National Park	**20**
NPS_ENP – Everglades National Park	**129**
NPS_SFWMD – National Park Service / South Florida Water Management District	**8**
SFWMD - South Florida Water Management District	**409**
USGS – U.S. Geological Survey (Both Water Resources Division and Biological Resources Division)	**197**
Total	**851**

South Florida Regional Assessments:

In addition, to the traditional land management role of the National Park Service, Everglades, Big Cypress, and Biscayne have the added unique role of reviewing proposed restoration plans and alternatives for the Department of Interior's Comprehensive Everglades Restoration Plan (http://www.evergladesplan.org/). This role requires extensive analysis of the trend in water quality and physical hydrology. As part of Everglades Restoration the most recent review is in "An Assessment of the Interim Operation Plan". The Interim Operational Plan (IOP) report is a compilation of analyses evaluating hydrological and ecological effects of IOP water management practices on the Everglades. This eight chapter report to Congress aims to assess IOP impacts to water quality and duration and make recommendations for future management activities. By

analyzing water quality, salinity, and hydrology monitoring data the IOP report assesses the impact of IOP management activities compared to Pre-IOP management activities on the Everglades ecosystem.

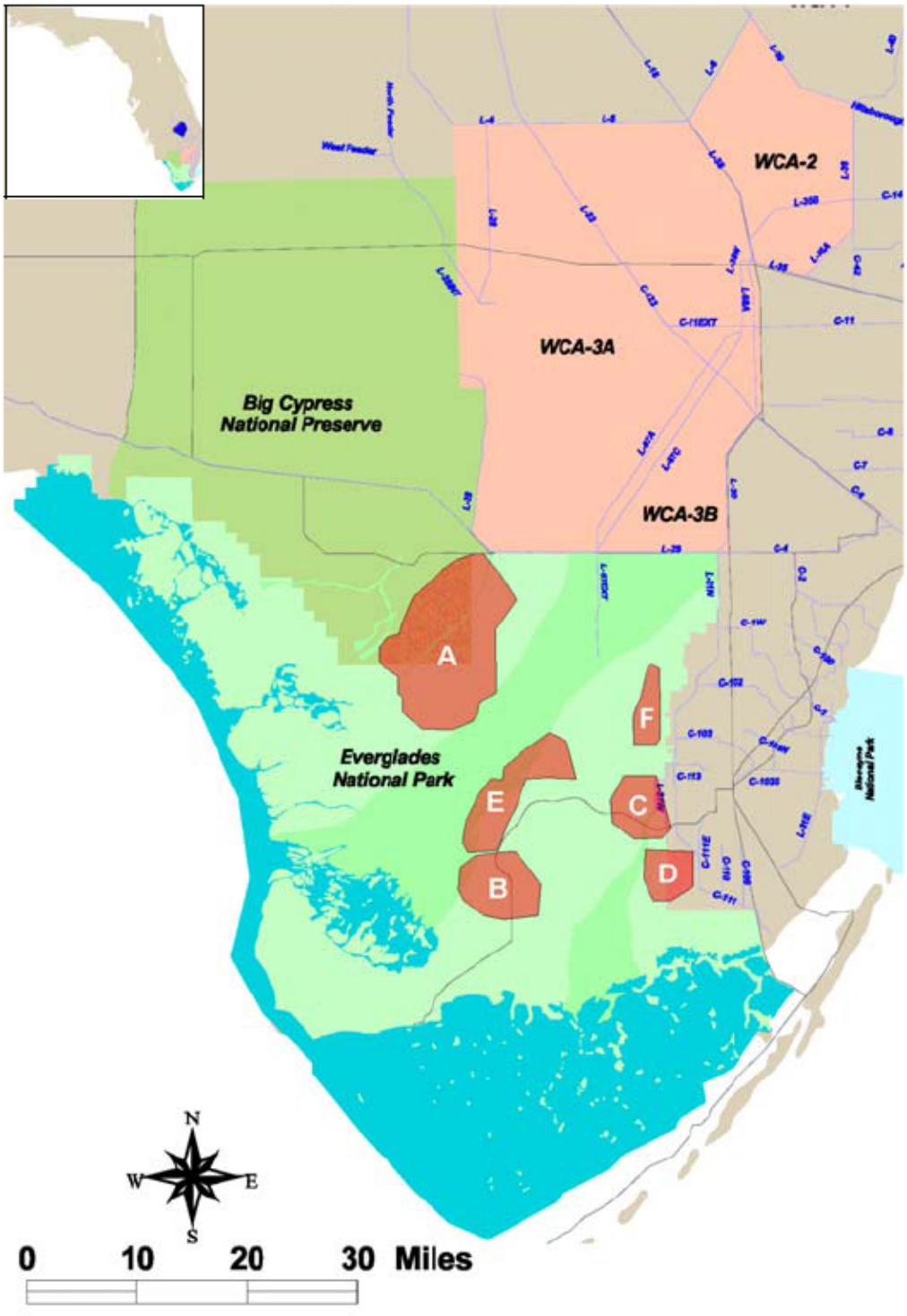
The Interim Structural and Operational Plan (ISOP) and /Interim Operational Plan (IOP) water management are attempts to improve the ecosystem quality of Everglades National Park. Rapid water level decline in the park due to water management actions has negative impacts on all organisms dependent on the current water depth. Pumps will be used to return seepage from Everglades National Park back into the system while maintaining a higher than average water detention level (NPS 2005).



Schematic showing the effects of canal drawdowns.

Hydrologic conditions beneficial to the Cape Sable Seaside Sparrow habitat are shallower than current trends. The Interim Operational Plan (IOP) was able to achieve these desired levels in the Central and Western Shark Slough providing an improved opportunity for nesting (see map below). The Northeast Shark Slough was unable to provide the necessary benefits to the Cape Sable Seaside Sparrow. The IOP resulted in a slight increase in water depth and reduction in seepage losses in the Rocky Glades. The Upper Taylor Slough showed a more natural timing and distribution of inundation due to the IOP. However, the Lower Taylor Slough and the Eastern Panhandle experienced no significant change in hydrologic conditions (Ahn et.al. 2005a).

Map showing the location of the areas occupied by the six (A-F) Cape Sable Seaside Sparrow sub-populations.



The Interim Operation Plan (IOP) increased salinity slightly in the Florida Bay and Gulf Coast Estuaries but the change was not statistically significant. Increased salinity is not generally desirable for the health of the Florida Bay ecosystem. Annual salinity increased at Shark River, Little Madeira, Terrapin Bay, North River, Whipray Basin , Duck Key and Butternut Key. Monthly mean salinity decreased during the dry seasons (November-January) and increased during the late dry/early wet season (February-July.) The salinity at Canepatch significantly increased during the month of March (see Fig 10 taken from Ahn et al. 2005b, letter codes indicate basin name ie. LM=Little Madeira). Additionally, IOP did not reduce salinity compared to the Test 7I period (1996-1999) in fact the salinity was always slightly higher but not statistically significant (see Fig 10 below)

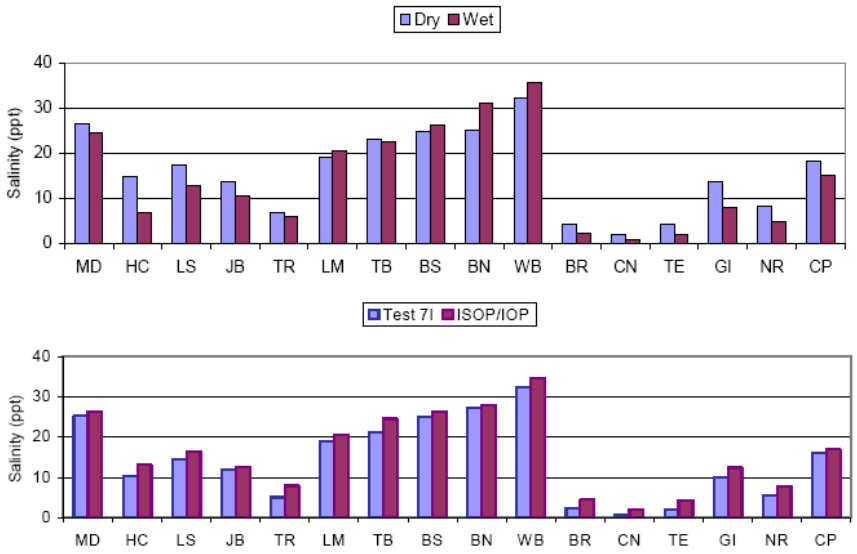


Figure 10. Comparison of historical salinity values: (a) between the wet and dry seasons, and (b) Test 7I and ISOP/IOP periods.

In the Comprehensive Everglades Restoration Plan, hydrological detention areas located outside of the parks are used to reduce total phosphorus (TP) amounts by 5-15% of incoming concentrations (generally in the range of 6-20 ppb). However, the TP concentrations during the Interim Operational Plan implementation increased in the soil and water of the Everglades National Park. Shark Slough had the largest rise of TP concentrations in its water and is a major concern of IOP implementation. Until water detention areas have adequate canal plugs and proper flow scheduling, future operational evaluations are needed to control water quality (Kadlec et al. 2005).

In addition to the IOP assessment, the Environmental Protection Agency (EPA) has a South Florida Ecosystem Assessment project. The South Florida Ecosystem Assessment Phase1/2- - Everglades Stressor interactions Hydropatterns, Eutrophication, Habitat Alteration, Mercury Contamination project goal was to provide scientific based management decisions to the Everglades ecosystem and its restoration. Essentially the Assessment project attempts to relate the four main areas of ecosystem influences:

Hydropatterns, Eutrophication, Habitat Alteration, and Mercury Contamination (see fig 54 taken from Stober et al. 2001).

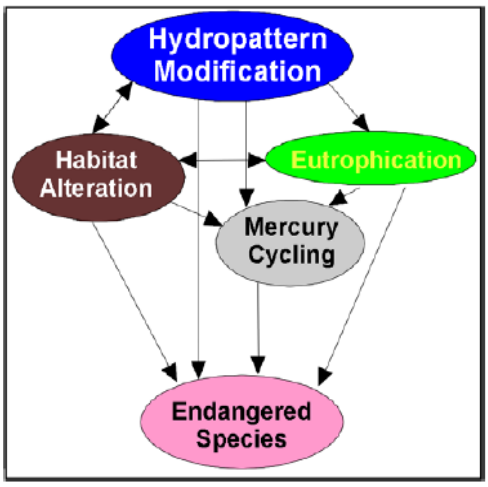


Figure 54. Restoration issues are highly interdependent and must be addressed together.

Hydropatterns

The depth, duration of inundation, and distribution of water has been altered by canal systems and levees built by the US Army Corps of Engineers (See Figure 7 below taken from Stober et al. 2001). Everglades Restoration is currently being implemented with the goal to return the hydrology to a more natural water flow pattern (more information at www.evergladesplan.org).

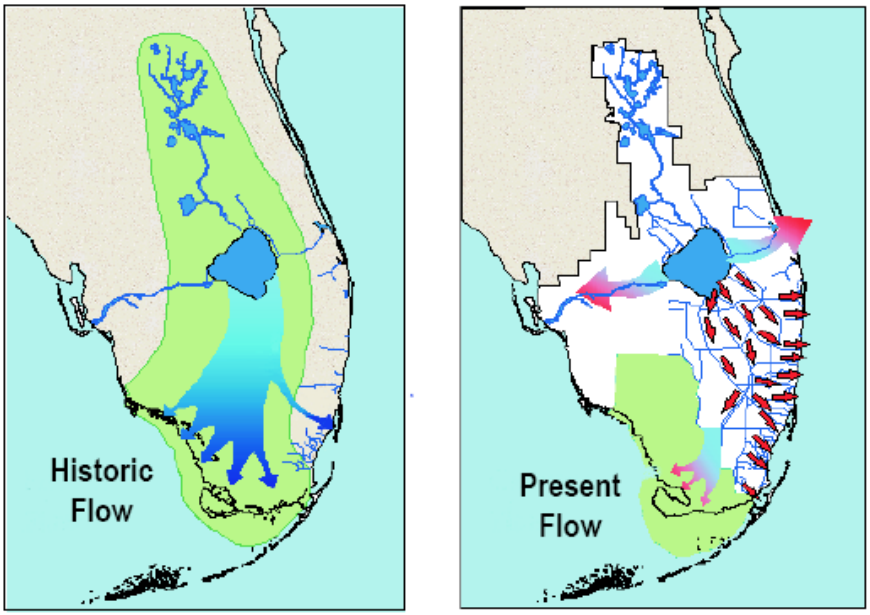


Figure 7. Historic flow pattern (left) and present flow patterns (right) through the South Florida system. Water movement is highly managed through the canals and water control structures.

Eutrophication

The Everglades Agricultural Area (EAA) and urban development contribute to nutrient overloading of Everglades National Park. Excess nutrients (eutrophication) can result in an increase of oxygen demanding organic matter which in turn reduces the amount of dissolved oxygen in the water. Waters with low to no oxygen (anoxic) generally do not support fishes and other macroinvertebrates. Thus the eutrophication reduces the food quality of wading bird habitats and can change the native sawgrass and wet prairie communities. In 1990, all discharges from the EAA were required to be reduced to 50 ppb phosphorus in an attempt to lessen the eutrophic impacts on the Everglades.

Habitat Alteration

The Everglades has lost over 1 million acres to urban development and agriculture since the beginning of the 20th century. The loss is irreversible and much of the remaining land and its ecosystems are altered from drainage changes/systems. Studies found that four major plant communities: sawgrass (*Cladium jamaicense*); water lily (*Nymphaea odorata*)-purple bladderwort (*Utricularia purpurea*); spikerush (*Eleocharis cellulosa*); and cattail (*Typha domingensis*) indicate ecosystem qualities, such as hydroperiod, water depth, soil type and nutrient requirements. As monitoring continues, changes in these indicator species may signal undesirable water quality and habitat alterations.

Mercury Contamination

Consumption advisories exist for over 2 millions acres of South Florida waters due to mercury contamination. Methyl-mercury is fat soluble and can be readily absorbed by biological organisms. This allows mercury to accumulate and move through the food chain, biomagnifying at each level (see Figure 39 below taken from Stober et al. 2001). The Regional Environmental Monitoring and Assessment Program (REMAP) was initiated to address mercury contamination issues in South Florida. Mosquito fish were used as the indicator species to test for mercury contamination (see Figure 32 below taken from Stober et al.). The U.S. Fish and Wildlife Service established a predator protection level of 100 ppb mercury in prey fish to prevent excessive bioaccumulation. Between Alligator Alley and Tamiami Trail, a hot spot was identified as having the highest mercury concentration in South Florida (Stober et al. 2001). Mercury poisoning is being investigated for its possible role in impacting Everglades's organisms.

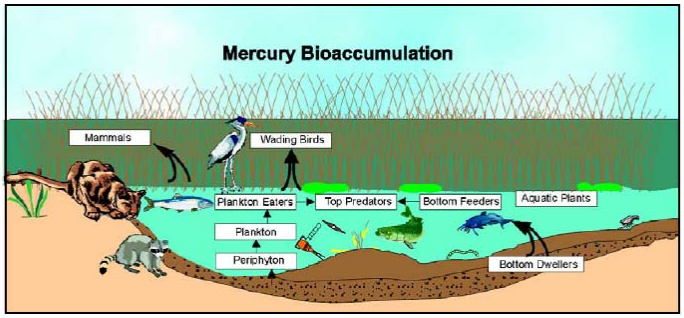


Figure 39. Bioaccumulation of mercury up the food chain from the water to wading birds and the Florida panther. Mercury concentrations in largemouth bass are over 1,000,000 times higher than methylmercury concentrations in water.

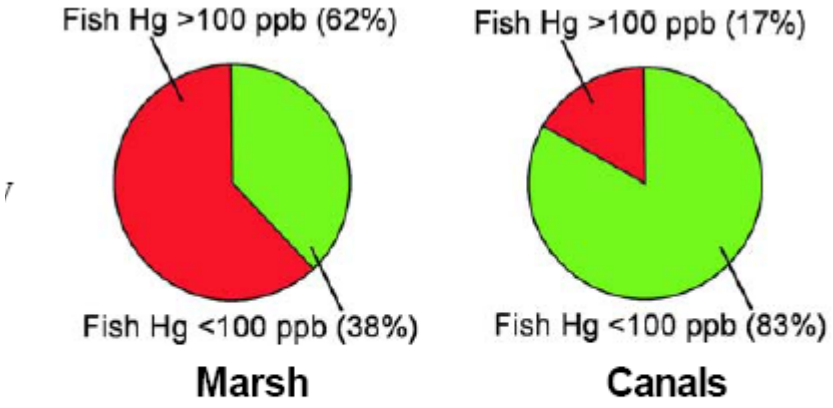


Figure 32. About 62% of the marsh area, compared to 17% of the canal miles, have mosquitofish with mercury concentrations exceeding the proposed predator protection level of 100 ppb.

The Virgin Islands Region View

The territorial government of the Virgin Islands Division of Environmental Protection / Department of Planning and Natural Resources Protection (DPNR/DEP) is the main agency monitoring water quality in Virgin Islands National Park. The DPNR/DEP maintains 135 monitoring stations across St. John, St, Croix, and St Thomas. These stations are sampled quarterly. In addition, there are 145 beach sites which are sampled for near shore water quality. SFCN has attempted to meet with Chris Crawford of the territorial government to explore water quality issues but direct exchange has not yet occurred.

Summaries generated by the Water Resources Division of the National Park Service indicate that all three Virgin Island parks have exceeded EPA screening criteria in the past. However, the verified 303d listing of water bodies would suggest that Virgin Islands and Salt River Bay National Historical Park and Ecological Preserve have greater human impacts than Buck Island Reef National Monument. This same view has been expressed a number of times by the resource management staff at the respective parks. In general, Buck Island water quality influenced by the greater Caribbean Sea than by terrestrial sources. Where as, Virgin Island and Salt River are being influenced by anthropogenic terrestrial sources.

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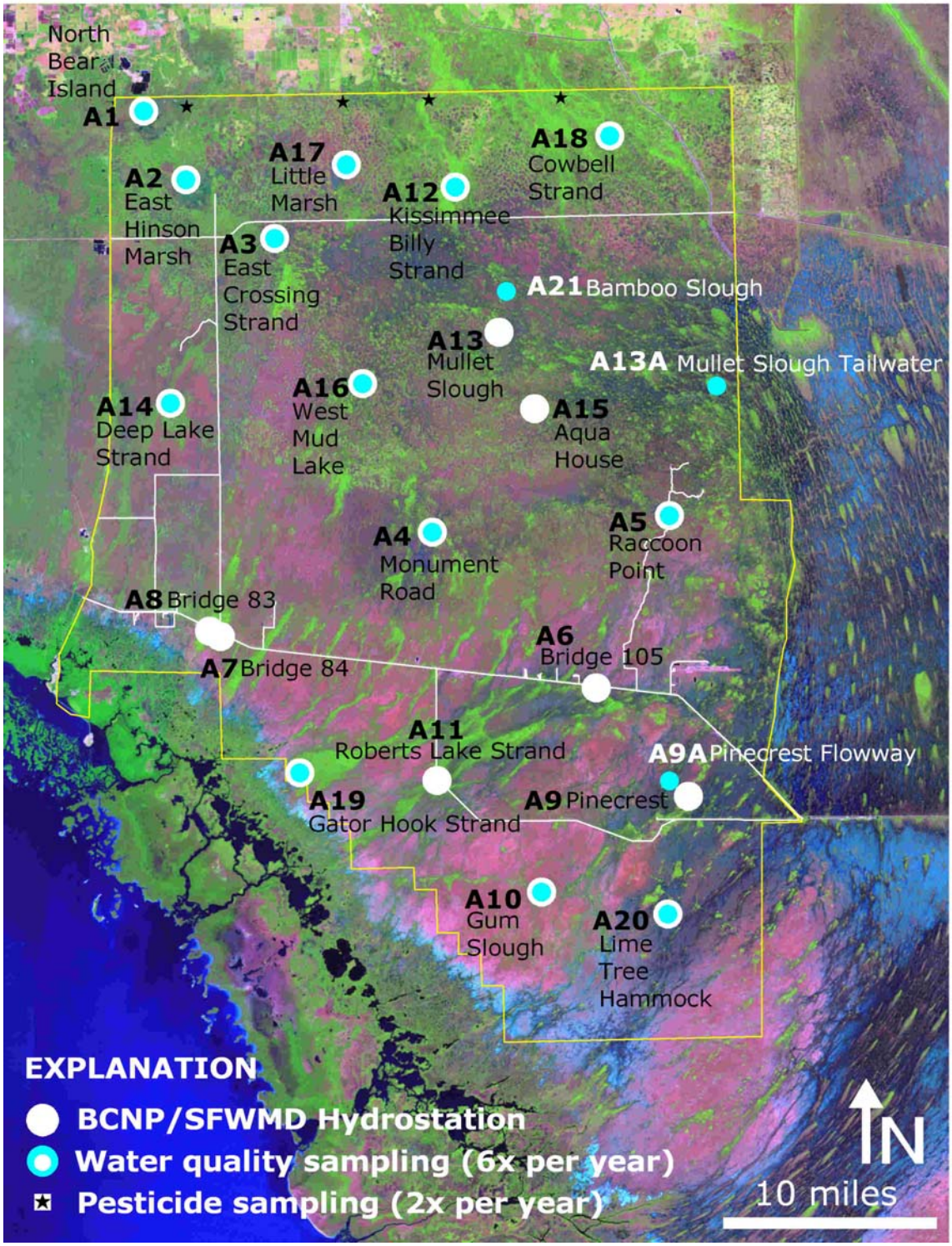
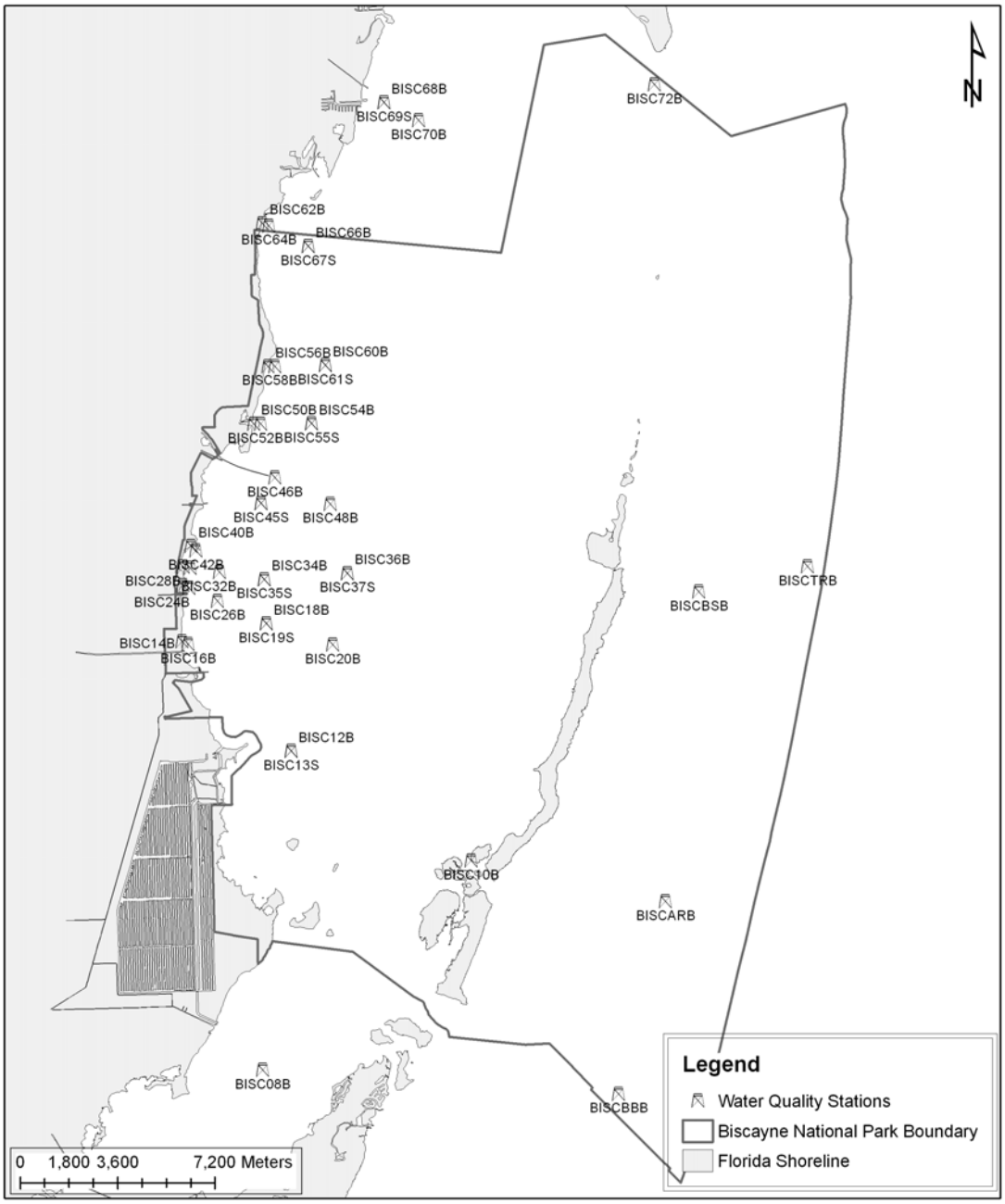
Supplemental information section

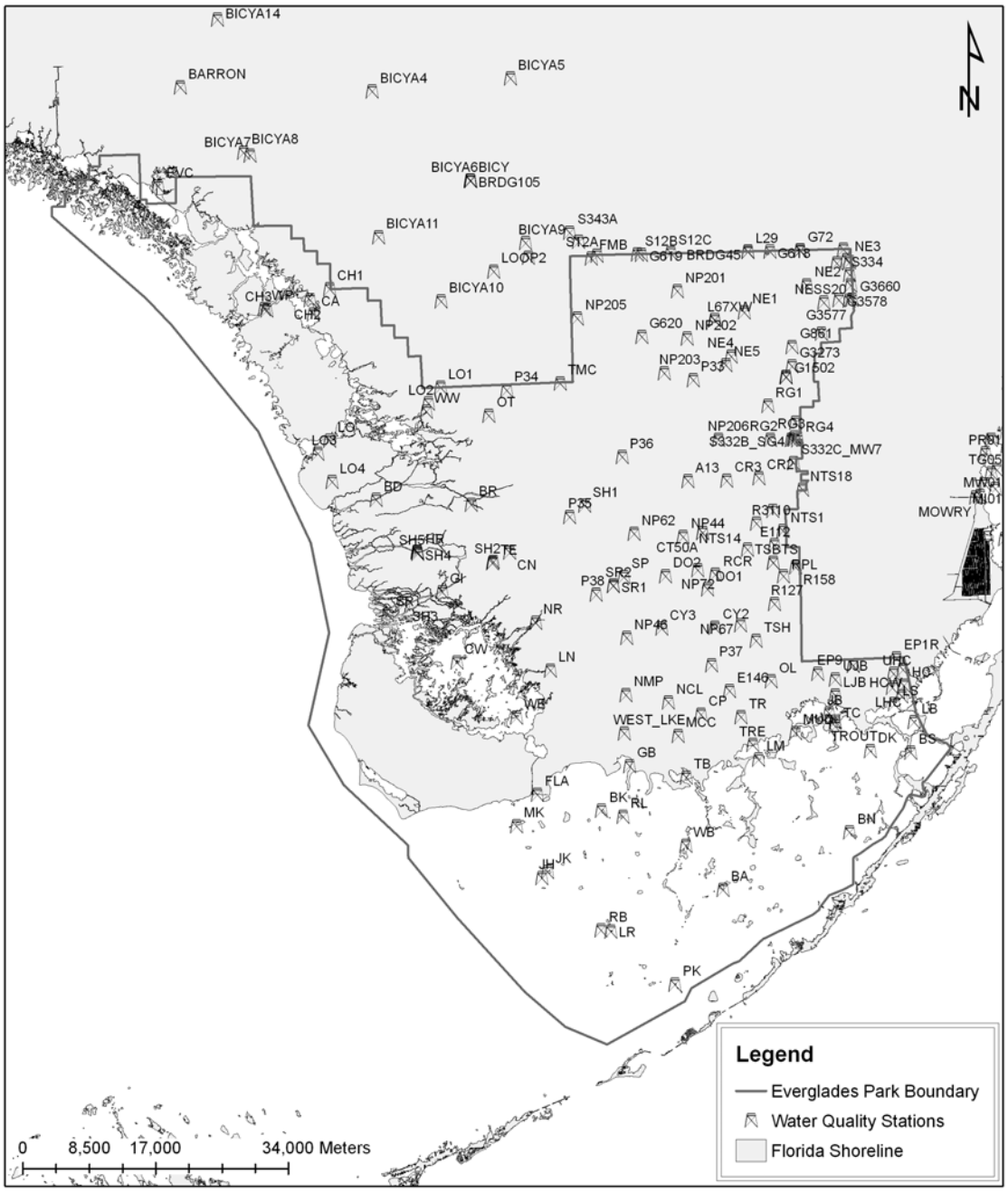
Big Cypress Preserve location of water sampling stations



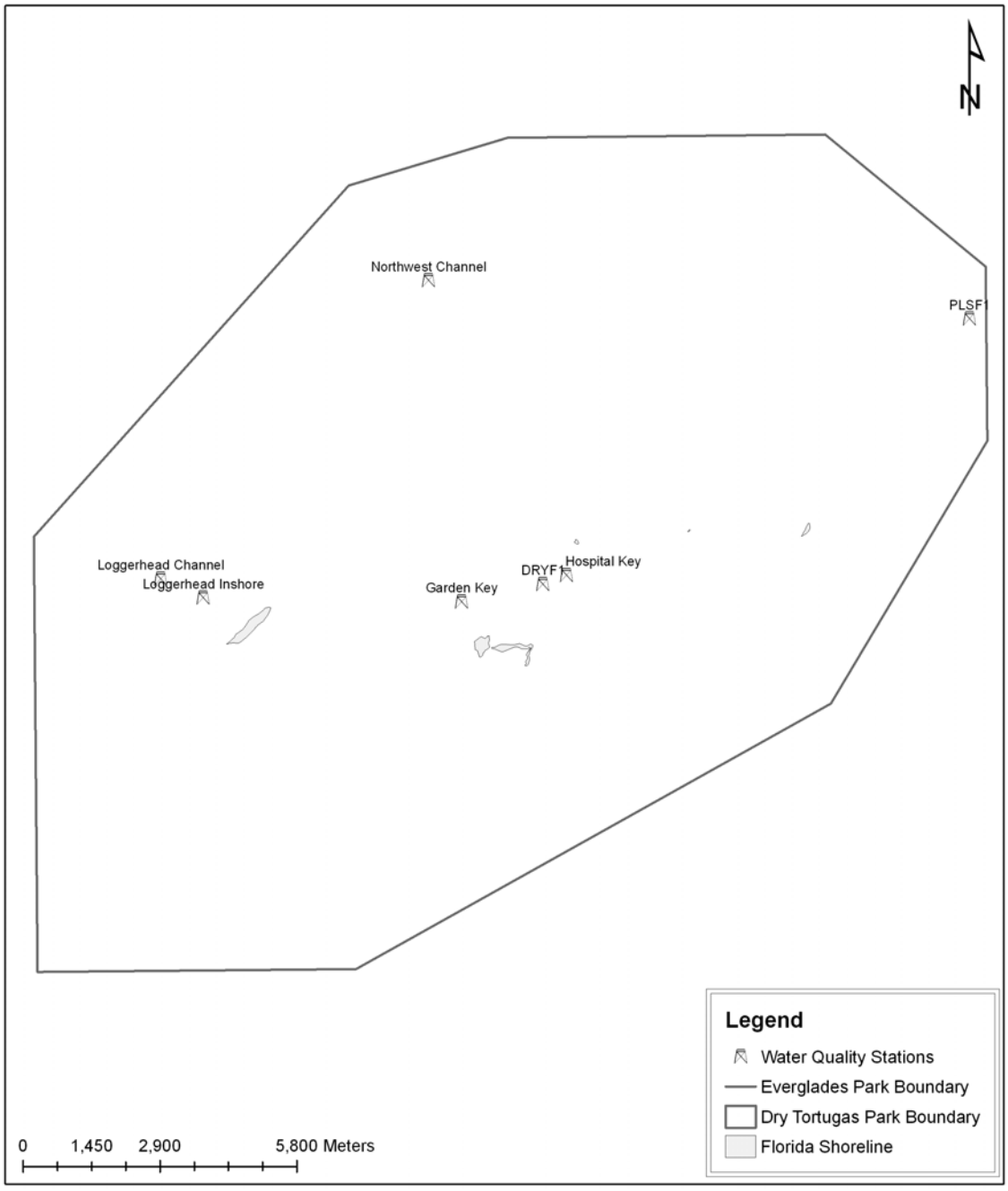
Water Quality Monitoring Stations
Biscayne National Park



Water Quality Monitoring Stations
Everglades National Park

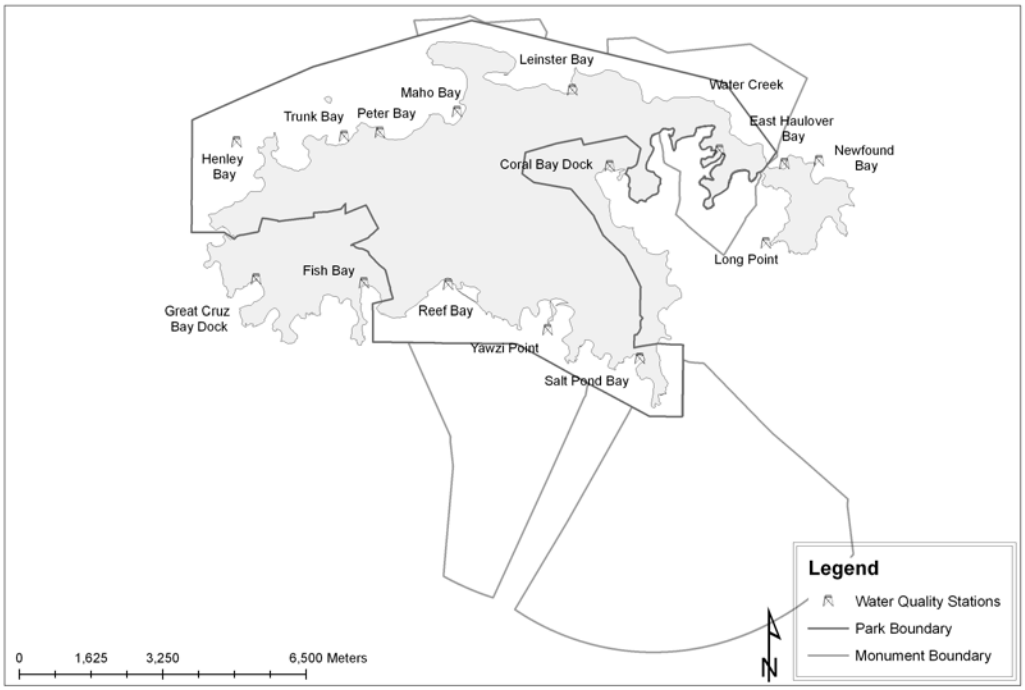


Water Quality Monitoring Stations
Dry Tortugas National Park



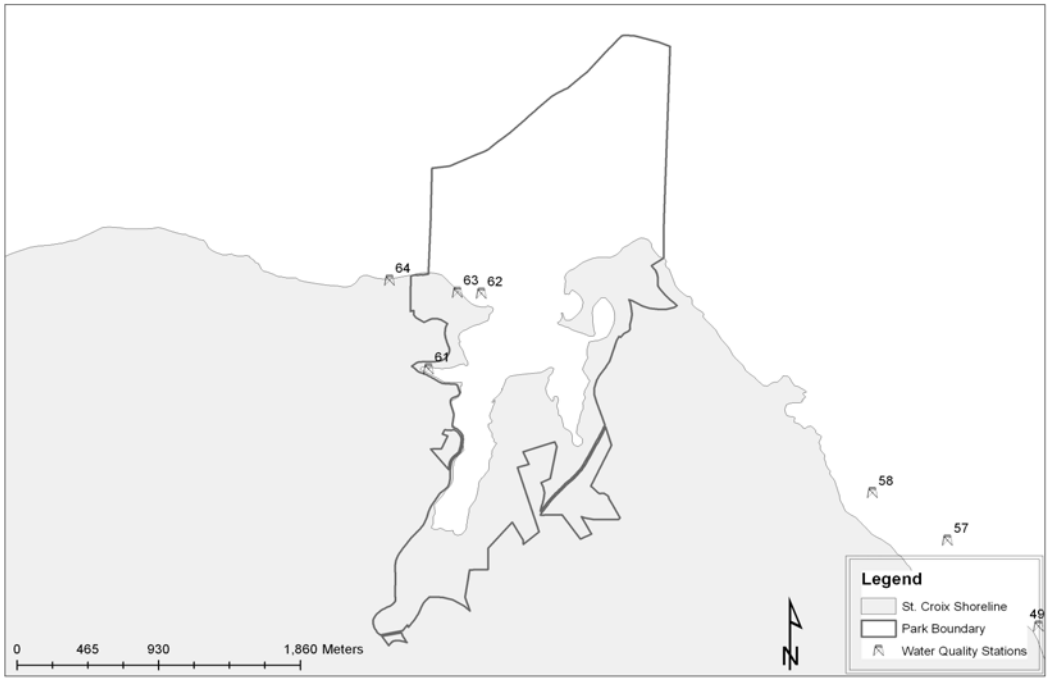
Water Quality Monitoring Stations

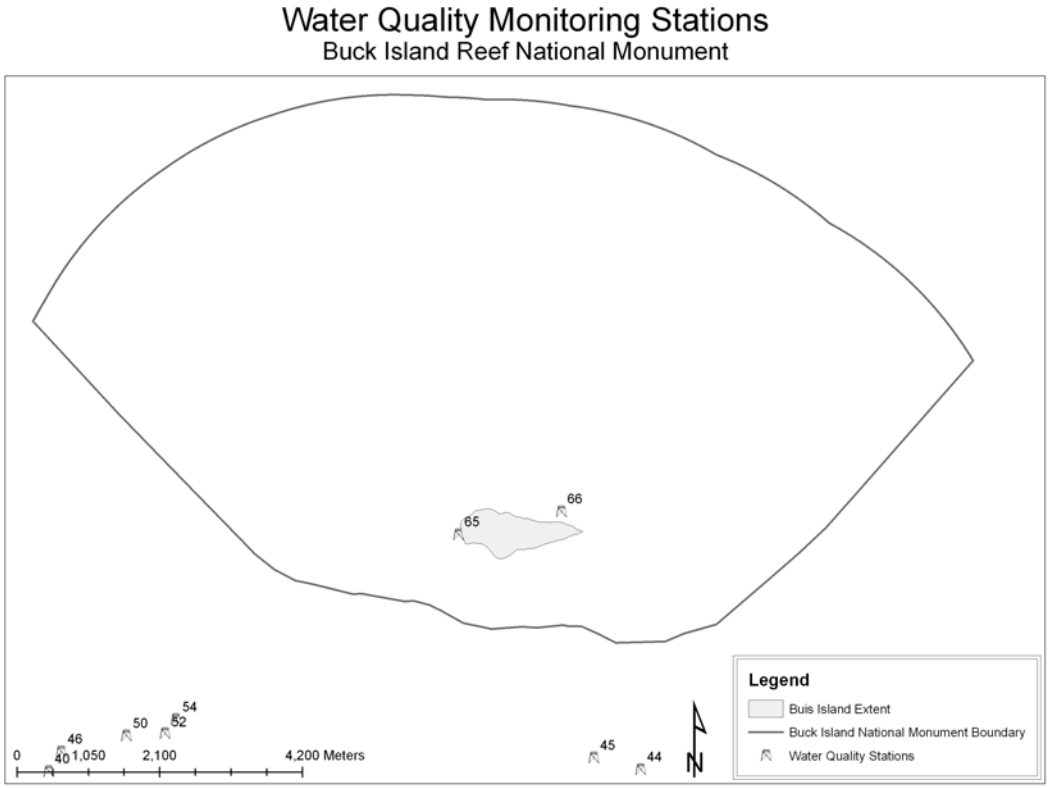
Virgin Islands National Park and Virgin Islands Coral Reef National Monument



Water Quality Monitoring Stations

Salt River Bay Naitonal Historic Park and Ecological Preserve




Water Quality Monitoring Stations
Buck Island Reef National Monument
66
65
54
52
50
46
40
45
44
0
1,050
2,100
4,200 Meters
N
Legend
Buis Island Extent
Buck Island National Monument Boundary
Water Quality Stations